

**ASSEMBLY OF ICS WITH BLOCKING CAPACITORS AND PRINTED  
CIRCUIT BOARDS**

CLAIM FOR PRIORITY

5 This application claims priority to German Application  
No. 10244976.7, filed September 26, 2002, and German  
Application No. 10250919.0, filed October 31, 2002, each  
filed in the German language, the contents of which are  
hereby incorporated by reference.

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TECHNICAL FIELD OF THE INVENTION

The present invention relates to an arrangement and  
method for the assembly of at least one blocking  
capacitor and printed circuit boards.

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BACKGROUND OF THE INVENTION

Due to the ever increasing integration of functionalities  
in existing integrated circuits (ICs), in particular  
ASICs and processors, there is a correspondingly growing  
20 number of inputs and outputs (pins). Because of the  
dynamic switching currents of these integrated circuits  
which increase with the operating frequency, an  
additional 30% to 50% of pins compared to the total  
number of pins are still required for the voltage supply.

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The housings for these integrated circuits therefore have  
to have a correspondingly large number of pins, to enable  
connection to a printed circuit board and thus to other  
components as well.

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If there is a very large number of pins for these  
integrated circuits, it is often customary to use  
housings in which the pins are arranged flat beneath the  
housing body, which is essentially rectangular. Ball grid  
35 array housings are preferably used having ball-shaped  
connector pins, which are arranged in a grid. The ball-  
shaped connector pins are frequently approx. 0.6 mm in

diameter. The distance between the centers of the ball-shaped connector pins is preferably approx. 1/20 inch.

When assembling integrated circuits on printed circuit boards, it is generally problematic to arrange blocking capacitors favorably. These blocking capacitors are required in the power supply path of the integrated circuit, as, due to the relatively high line impedance of the supply lines (for example in the order of 100 Ohm), rapid current changes at high switching frequency cannot be offset via this channel. For the integrated circuit to function properly, it is therefore necessary to feed the current to the power supply terminals (power supply pins) via a low-ohm and broadband connection. For this purpose, these blocking capacitors are required in particular, which are connected to the supply voltage terminals with the lowest possible inductance. On the one hand, blocking capacitors must therefore be selected, which themselves have the lowest possible self-inductance.

Apart from self-inductance, the feed inductance between the blocking capacitors and IC pins is naturally crucial. It should therefore be ensured that the blocking capacitors are positioned as close as possible to the supply voltage pins.

Fig. 1 is a diagrammatic representation of a known assembly technique for an integrated circuit 1 in a housing body 8 on conducting paths 5 of a printed circuit board 4. As can be seen in Fig. 1, the integrated circuit 1 is directly contacted to the conducting paths 5, 7 of the printed circuit board 4 by means of, for example, ball-shaped connector pins 2, 3.

With the known technique according to Fig. 1, blocking capacitors 6 are arranged next to the housing 8 of

integrated circuit 1 or on the side of the printed circuit board 4 facing away from the housing 8.

This known technique is disadvantageous in several ways. Because of the considerable connection lengths of the current paths between the blocking capacitors 6 and integrated circuit 1 due to the arrangement of blocking capacitors 6, high series feed inductances are produced, leading to a deterioration in the blocking characteristics.

Furthermore, the space requirements are greatly dependent on the number of blocking capacitors 6.

A further possibility not shown in the figures is to integrate the blocking capacitors in the housing of the integrated circuit itself. This variant, however, is disadvantageous in that it increases the housing costs, which means that this known technique can only be applied in special cases.

#### SUMMARY OF THE INVENTION

The present invention relates to an arrangement comprising an integrated circuit in a housing with connector pins, a printed circuit board and at least one blocking capacitor. The invention also relates to a method for the assembly of at least one blocking capacitor. In addition, the invention relates to the assembly of suitable carriers.

The present invention also discloses a technique for assembling integrated circuits in housings, with it being possible to arrange the blocking capacitors at low cost, requiring little space and generating low feed inductances between the blocking capacitors and the integrated circuit.

According to one embodiment of the invention, an arrangement is proposed, comprising an integrated circuit in a housing, in turn comprising a plurality of connector pins. The arrangement also comprises a printed circuit board having conducting paths, to which the integrated circuit is electrically and mechanically contacted by means of the above-mentioned connector pins of the housing. In addition, at least one blocking capacitor is switched into a power supply path for the integrated circuit external to the housing.

According to the present invention, at least one blocking capacitor is spatially arranged between the connector pins of the housing and is electrically contacted thereto. In other words, the blocking capacitors in the grid are placed between the connector pins, or are positioned in slots or spaces not occupied by connector pins.

It is in particular possible to surround the integrated circuit by a BGA (ball grid array) housing, the connector pins of which are ball-shaped. This makes it possible to insert the connector pins through openings, preferably bore holes in a carrier, in particular a heat-resistant carrier foil. In this way it is possible for the blocking capacitor, of which there is at least one, and the printed circuit board to be positioned on the side of the carrier facing toward or away from the housing, depending on whether the carrier is arranged further toward the housing or further toward the printed circuit board.

The blocking capacitor, of which there is at least one, can be bonded to the carrier, preferably the carrier foil, between two openings. It can also be inserted into the carrier between two openings, such that both sides of the blocking capacitor project from the carrier and the carrier occupies a central position.

According to another embodiment of the present invention, a carrier is provided which comprises openings, through which connector pins of a housing surrounding an integrated circuit can be inserted and at least one blocking capacitor, which is mounted on the carrier between two openings or which is centrally positioned compared to either side of the carrier. The carrier can be made of a heat-resistant foil.

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According to still another embodiment of the present invention, there is a method is provided to assemble at least one blocking capacitor. This blocking capacitor is arranged in a power supply path for an integrated circuit, which has a housing with a plurality of connector pins. The connector pins are electrically and mechanically contacted to conducting paths of a printed circuit board arranged in proximity to the housing. In addition, the blocking capacitor, of which there is at least one, is spatially arranged between the printed circuit board and integrated circuit and is contacted to the connector pins of the housing of the integrated circuit.

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In this way, the blocking capacitor, of which there is at least one, can be assembled before assembly onto or into the carrier between two openings thereof. The connector pins are thus inserted through the openings of the carrier positioned between the housing and the printed circuit board.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Further features, advantages and characteristics of the present invention are described in more detail for the person skilled in the art by means of the following detailed description of an exemplary embodiment referring to the figures of the accompanying drawings.

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Fig. 1 shows a known technique for assembling integrated circuits in housings with blocking capacitors and a printed circuit board.

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Fig. 2 shows a first phase of the technique according to the invention to assemble blocking capacitors between connector pins of a housing of an integrated circuit.

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Fig. 3 shows the final phase of this assembly technique according to the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

15 The housing 8 of an integrated circuit can be seen in Fig. 2, with the housing 8 preferably being a BGA (ball grid array) housing 8 having ball-shaped connector pins 2, 3. From the exemplary embodiment shown, which does not show the printed circuit board, it can be seen that, as a  
20 further component, a carrier foil 10 is provided, having openings, e.g. bore holes 9, for the ball-shaped connector pins 2, 3 of the BGA housing. The openings, e.g. bore holes 9, are arranged and dimensioned such that the ball-shaped connector pins 2, 3 of the BGA housing 8  
25 can insert into them, if the carrier foil 10 is correctly aligned therewith during the assembly.

It can also be seen from Fig. 2 that the blocking capacitors 6 are mounted on the side of the foil 10  
30 facing away from the BGA housing 8 between openings 9 of the foil 10 and are in particular connected to the foil 10 by means of a bonding 11. Although this is not shown in Fig. 2, it is conceivable for the blocking capacitors to be mounted on the side of the foil 10 facing toward  
35 the BGA housing 8 between the openings 9 of the foil 10 or to be inserted into the foil 10, such that both sides of the blocking capacitors project from the foil.

In the assembly according to the invention, the preassembled carrier foil with blocking capacitors is thus connected first to the BGA housing 8, by inserting  
5 the ball-shaped connector pins 2, 3 into the openings 9 of the carrier foil 10.

Then, as shown in Fig. 3, the ball-shaped connector pins 2, 3 of the BGA housing 8 are soldered to the conducting  
10 paths 5 of the printed circuit board 4 by means of contacting. This creates an electrical and mechanical connection between the printed circuit board 4 and the integrated circuit 1 within the BGA housing 8. The blocking capacitors 6 which are mounted on and, in  
15 particular, bonded to the carrier foil 10, are now positioned spatially on the one hand between the printed circuit board 4 and the BGA housing 8 and on the other hand, again spatially, between the ball-shaped connector pins 2, 3 of the BGA housing 8. At the same time in this  
20 phase, the blocking capacitors 6 are also soldered to the conducting paths 5.

As can be seen in Fig. 3, the electrical contacting between the blocking capacitors and the respective  
25 connector pin 2, 3 of the power supply for the integrated circuit 1 takes place via electrical conducting paths 5. As an alternative or in addition, it is also naturally possible for the blocking capacitors 6 to be mechanically and/or electrically contacted to the ball-shaped  
30 connector pins 2 and/or 3.

As shown in Fig. 3, it is thus advantageous for the current path 7 now created between the blocking capacitors 6 and the integrated circuit 1 to be  
35 considerably reduced, which in turn will improve the blocking characteristics.

The invention therefore provides for the direct attachment of the blocking capacitors to the connector pins ("balls").

5 This produces the following advantages:

- minimum series inductances for blocking capacitors external to the housing and thus effective blocking of discrete sets)
- 10 - no additional space requirements on the printed circuit board, and
- the technology according to the invention is compatible with the available fabrication techniques for SMD (surface mounted device) components.

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The direct application of blocking capacitors to the supply voltage pins on the same side of the printed circuit board thus reduces the parasitic inductances connected to the feed lines.

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It is pointed out that Figures 2 and 3 only show an exemplary embodiment enabling the use of a carrier foil fabricated specifically for ASICs and having blocking capacitors bonded thereto (e.g. heat-resistant foil with a hole grid in line with the BGA balls). When assembling the printed circuit board, this carrier foil is treated as a separate component, which is precisely positioned beneath the BGA housing.

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30 Alternatively, it is possible to bond individual blocking capacitors, also specific to ASICs, to the printed circuit board between the terminal paths of the BGA balls using what are referred to as pick-and-place machines.